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Strip Mining, *Peromyscus* and Other Small Mammals in Southern Iowa[1]

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Small mammal presence, diversity and reproduction were compared from summer 1975 to summer 1976 on abandoned coal strip mine spoils and unmined land in southern Iowa. More species were trapped on the unmined area, while the relative dominance of *Peromyscus* spp. on mined land was greater. *Peromyscus* populations on mined land exhibited a shorter breeding season than on unmined land. Other population parameters did not show clear differences between the areas.
INDEX DESCRIPTORS: *Peromyscus*, small mammals, Iowa, strip mining.

Literature accounts of Iowa small mammals are mainly species lists and distribution records, and have little reference to population data. This study was undertaken to compare species diversity, abundance, and reproduction of small mammal populations on abandoned coal strip mines and nearby unmined land, with particular attention to *Peromyscus* spp. Since climatic and vegetation conditions in Iowa are substantially different from those in areas studied by others, this analysis also compares small mammal communities on Iowa coal spoils with those farther east.

Approximately 4500 ha have been strip mined for coal in Iowa, mostly in the southeastern part of the state. Strip mining eradicates the soil profile and plant and animal life by piling overburden in parallel steep ridges separated by narrow draws. The surface of the strip mined land is often characterized by high acidity (due to the oxidation of pyrites), unusual chemical concentrations, large daily temperature changes, low soil moisture, and severe erosion; a generally harsh environment for mammals and other organisms prevails.

Yeager (1942) and Verts (1959) compiled lists of mammal species and their estimated abundances on Illinois coal spoils. Verts (1957), Wetzel (1958) and Hansen and Warnock (1978) found *Peromyscus maniculatus* dominant on younger Illinois spoils where weeds and grasses comprised the vegetation, while *P. leucopus* was dominant on older spoils with more shrubs and trees. Similar patterns were found in Indiana, although species distribution could not be correlated with age or soil conditions because the nature of the spoil varied independently of age (Sly, 1976). Mumford and Bramble (1969) reported high densities of *Peromyscus* and very low densities of other small mammal species on Indiana spoils. DeCapita and Bookhout (1975) found capture rates of several species (e.g. *Peromyscus* spp., *Sylvilagus floridanus*) comparable to or higher than those on unmined land.

Study area

The abandoned strip mined area was the Wilcox Wildlife Preserve, SE Marion Co., with about 250 ha mined between 1952 and 1962. The unmined site was the area around the Iowa Coal Project (ICP) Demonstration Mine No. 1, in SW Mahaska Co., about 15 km east of the mined site. The Wilcox Wildlife area had a highly heterogeneous vegetation, consisting of a mixture of grass, shrub, open woodland, and bare areas. The distribution of vegetative cover (or lack of it) was related to substrate conditions (Glenn-Lewin, 1979). The ICP Demonstration Mine site was an alfalfa (*Medicago sativa*) hay field mixed with a number of other grass and forb species and surrounded by roadsides dominated by *Bromus inermis* and by grassy drainage ways and open woodland.

The region has a rolling topography, with elevations of 180-300 m, and is in the Des Moines River drainage. Soils in the region are alluvial in the valleys and river bottoms, Kansan till on the slopes and loess on the hilltops. Bottomlands and lower slopes were originally vegetated with forest, and are now covered with secondary woods and brush; some of the wider bottomlands are now in crops. Crops and pasture have replaced the original tall grass prairie on the upper slopes.

The area has cold winters and hot summers. Mean annual temperature is 11°C; mean January temperature is −5°C and mean July temperature is 25°C. Mean annual precipitation at nearby Knoxville (279 m elev.) is 830 mm, 70% of which falls in the 6 months from April to September. The mean frost-free period is 170 days. During this study, winter snow cover was light, and winter temperatures were warmer than normal.

METHODS

Small mammal populations were sampled approximately monthly from August, 1975 to July, 1976 by snap traps baited with peanut butter and rolled oats. Traplines of 15 stations with 2 traps each were run 5 nights, except in September and October, 1975, when 10 stations of 3 traps each were run 4 nights, at the unmined site only. Traplines were placed in representative habitats (draws, ridgetops, open areas, grassy areas, etc.). Each month traps were placed near those of the previous month (in the same habitat type), but not in the same places, to avoid overtrapping of a particular area.

Peromyscus leucopus and *P. maniculatus* were abundant enough to describe population characteristics of these species. They were classified by age according to pelage color. Grey coats were classed as juveniles, mottled coats as subadult and brown coats as adult. Based on internal and external characteristics, females were categorized as lactating, pregnant or nonreproductive. Males were considered reproductively active if testes were enlarged and descended.

RESULTS AND DISCUSSION

Abundance and Diversity

Peromyscus leucopus was the most frequently captured species both on mined and unmined land, followed by *P. maniculatus* (Table 1). These 2 species made up 56% of the catch on unmined land and 87% on the strip mined area (see Table 1). The importance of *Peromyscus* spp. on the spoils is illustrated by a high concentration of dominance, as measured by Simpson's Index (Simpson, 1949). The on-spoil index was 0.40, the unmined index was 0.22. Although the assumption of equal trapability for all species probably does not hold in the present case, the differences between the areas are nevertheless substantial because the index is based on a sum of squares. *Peromyscus* dominance in early successional stages is typical in North America (Beckwith, 1954; Pearson, 1959; Shure, 1970; Kirkland, 1976). Similar results

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Table 1. *Captures of small mammals on mined and unmined land.*

Species	Number taken on spoils [a]	Number/100 trap nights	% of capture	Number taken on unmined land [b]	Number/100 trap nights	% of capture
Peromyscus leucopus	226	6.5	52.1	114	4.2	37.4
Peromyscus maniculatus	151	4.4	34.8	57	2.1	18.7
Microtus pennsylvanicus	18	.5	4.2	10	.4	3.3
Sorex cinereus	17	.5	3.9	22	.8	7.2
Reithrodontomys megalotis	14	.4	3.2	31	1.2	10.2
Blarina brevicauda	7	.2	1.6	4	.2	1.3
Microtus ochrogaster	1	< .1	.2	17	.6	5.6
Mus musculus	0			48	1.8	15.7
Zapus hudsonius	0			1	< .1	.3
Cryptotis parva	0			1	< .1	.3
TOTALS	434	12.6	100.0	305	11.3	100.0

[a] 3456 trapnights
[b] 2690 trapnights

have been reported on strip mined land by Yeager (1942), Verts (1957, 1959), Wetzel (1958), Mumford and Bramble (1959), deCapita and Bookhout (1975), Sly (1976) and Hansen and Warnock (1978). Eight species of lesser frequency were found on unmined areas, and 5 on mined land, which lacked *Mus musculus, Cryptotis parva,* and *Zapus hudsonius* (Table 1).

Seasonal fluctuations in total capture rates were found in both mined and unmined areas. Capture rates peaked in December (25/100 trap nights on the unmined area, 23/100 trap nights on the mined area), then declined until March (9/100 trap nights on the unmined area, 8/100 trap nights on the mined area). Captures reached a secondary peak in May (12/100 trap nights on the unmined area, 17/100 trap nights on the mined area), and then declined into summer (8/100 trap nights on the unmined area, 6/100 trap nights on the mined area in September). The total capture rate on the unmined area was slightly lower than on the mined area (Table 1), although monthly rates on the unmined area were somewhat higher in September, and from December through March. Hansen and Warnock (1978) also found that fall-winter captures of *Peromyscus* on Illinois spoils were usually greater than in spring-summer.

Habitat Selection

Grassy habitats of both mined and unmined land had higher diversity than wooded habitats. *P. maniculatus* was the dominant species in grassy habitats of both areas (35% of captures on unmined, 48% on mined land). In wooded habitats, *P. leucopus* was the most common catch, 81% of the capture on unmined land and 92% on the spoils. The preference of *P. leucopus* for vertically oriented habitats, and that of *P. maniculatus* for open areas, are well documented (Dice, 1922; Blair, 1940; Jameson, 1949; Getz, 1961; Iverson *et al.*, 1967).

Along spoil ridges, *P. maniculatus* constituted 55% of the captures, while *P. leucopus* made up 37%. Although only 15% of the trap effort was exerted on spoil ridges, 39% of all *Microtus pennsylvanicus* were captured there. The typically low soil moisture on the coal spoils, especially on the ridges, suggested that *M. ochrogaster* would be the more common microtine due to its apparent preference for drier habitats (Miller, 1969; Lewin, 1968). Normal habitat segregation of *Microtus* spp. was observed in unmined areas. Trapping in spoil draws resulted in 62% *P. leucopus* and 30% *P. maniculatus*. The larger capture of *P. leucopus* in draws (wooded) and of *P. maniculatus* on ridges (grassy due to heavy erosion and periodic desiccation), reflects the vegetation of these habitats. On spoil areas, *Reithrodontomys megalotis* occurred only in well-vegetated draws. Other species were captured in habitats expected for those species; low capture rates prevent a quantitative description of habitat selection by the uncommon species.

DeCapita and Bookhout (1975) found a high concentration of dominance and lower species richness of mammals on Ohio coal spoils,

concluding these habitats were inferior to habitats on unmined land. Low mammal diversity is also associated with the low quality of Iowa coal spoil habitats.

Reproduction

Both species of *Peromyscus* had shorter breeding seasons on mined than on unmined land. Males from unmined habitats were found with scrotal testes in all months (no *P. leucopus* males were captured in August; no *P. maniculatus* males were taken in November). On mined land, no scrotal testes were found in male *P. leucopus* in November or December, and none in *P. maniculatus* from November through February. In mined areas, no female *P. leucopus* were pregnant from November through April; no *P. maniculatus* females appeared to be breeding from November through March. In unmined areas, females of both species were not reproductively active from November to February. Orr-Ewing (1950), comparing *P. leucopus* populations from burned, clear-cut and natural forest areas, found shorter breeding seasons in populations from habitats with reduced vegetative cover. *Peromyscus* may breed extensively during winter in habitats with good cover and food supplies and during mild winters (Linduska, 1942; Brown, 1945; Wood, 1910). The differences in the length of the breeding season observed here probably reflect an inferior food supply and cover on the mined land, since the winter weather was quite mild.

There were no differences between proportions of breeding females of either species ($p > 0.05$) on the 2 sites. Of 59 mature female *P. leucopus* from unmined habitats, 13 were reproductively active; 5 were pregnant, with an average of 3.6 embryos. Of 90 female *P. leucopus* from the mined area, 32 were reproductively active: 13 were pregnant, with an average of 4.9 embryos. Embryo counts (both areas) ranged from 2 to 8. Literature accounts (e.g., Burt, 1940; Svihla, 1932) report litter sizes somewhat over 4. Of 24 female *P. maniculatus* from unmined areas, 6 were reproductively active; 3 were pregnant, with 4.3 embryos. Of 70 female *P. maniculatus* from mined areas, 24 were reproductively active; 17 of these were pregnant, averaging 3.7 embryos. Embryo counts (both areas) ranged from 1 to 5. Reported litter sizes from the Midwest range from 3.05 to 5.2 (Svihla, 1932; Linduska, 1942; Beer *et al.*, 1957; Beer and MacLeod, 1966; Long, 1968).

Age ratios did not differ between the 2 areas. Immatures were 24% of the *P. leucopus* population and 29% of the *P. maniculatus* population on mined land. On unmined land, immatures were 25% of the *P. leucopus* population and 28% of the *P. maniculatus* population.

Sex Ratio

Of adult *P. leucopus* from mined areas, 58% were male; 62% of 53 immatures were male. On Illinois spoils, Verts (1957) found similar values, 61% of the adults and 30% of the immatures were males. Adult populations of *P. leucopus* from unmined areas contained 47% males (the difference between mined and unmined is significant: $\chi^2 = 4.12$, $p < 0.05$) and 39% of 28 immatures were male. *P. maniculatus* sex ratios from both habitats were near an even ratio and similar to each other (mined 53%, unmined 56% male). Too few immature *P. maniculatus* were taken for a valid comparison. Verts (1957) found 61% of adult and 56% of immature *P. maniculatus* were males.

Body Size

No difference in average *Peromyscus* body length, compared by sex, were found in mined or unmined areas, and no differences were found in comparison to the Iowa data of Sloan (1964). The only significant variation in body dimensions was body weight of adult male *P. leucopus*. From unmined areas, average weight was 27.5 g; from mined areas, weight averaged 25.8 g ($p < 0.05$). The reason for this is unknown.

CONCLUSIONS

In this study, field data were analyzed for differences in species diversity, abundance, reproduction and population parameters of small mammals on strip mined and unmined land in southeast Iowa. The main conclusions are:

1. Small mammal species diversity was lower on strip mined land and relative abundances of species were changed. The unmined land had 10 species, the mined land had 7. More *Peromyscus* were captured on mined than on unmined land.
2. *Peromyscus* breeding seasons were shorter on the mined than on the unmined land.
3. Age ratios, incidence of pregnancy and litter sizes of *Peromyscus* were not significantly different between the 2 areas. Some differences in body size and sex ratio were noted, but overall the results were equivocal and no obvious trends were found.

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